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ABSTRACT

An analysis of salary differentials shows that although women and racial or ethnic minorities in the federal Civil Service science and engineering workforce earn less than their male and white counterparts, the differentials are much less than those shown by other studies for other occupations in the economy. These results show that: (1) salary differentials are lower among scientists and engineers regardless of sector of employment; (2) differentials between men and women and among racial/ethnic groups in all occupations are narrower within the Civil Service than outside it; or (3) the differentials are narrower for federally employed scientists and engineers than for this workforce in other sectors. Numerous charts, graphs, and tables illustrate this report, and technical notes and formulas are included. (Author/MSE)

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# Sex and Ethnic Differentials in Employment and Salaries Among Federal Scientists and Engineers

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## Summary

Salary differentials between men and women and among racial/ethnic groups have been noted by many studies of occupations in the United States. These studies typically show that, before accounting for differences in characteristics such as work experience and education, males earn 50 percent to 80 percent more than women, and whites earn 35 percent to 65 percent more than blacks. Even after accounting for characteristic differences, these studies show men earning 24 percent to 63 percent more than women, and whites earning 22 percent to 43 percent more than blacks.[1]

Salary differentials also exist among these groups within the population of federally employed scientists and engineers—the group constituting the focus of this study. In late 1977 the average salary of federally employed women scientists and engineers was three-fourths that of men. Depending on ethnic group, the average salary of minority scientists and engineers was between 8 percent and 13 percent less than that of whites. However, factors such as experience, occupation, education, and geographic area of employment explain about 60 percent of the male/female differential and about one-third of the minority/nonminority differential. After controlling for these characteristics, the differential narrows to 8 percent by sex, and 5 percent to 7 percent by minority group.

This analysis of salary differentials shows that although women and racial/ethnic minorities in the Civil Service science and engineering (S/E) work force earn less than their male and white counterparts, the differentials are much less than those shown by other studies for other occupations in the economy. These results show that: (a) salary differentials are lower among scientists and engineers regardless of sector of employment; (b) differentials between men and women and among racial/ethnic groups in all occupations are narrower within the Civil Service than outside it; or (c) the differentials are narrower for federally employed scientists and engineers than for S/E employees in other sectors.

## Introduction

Female and minority populations are important resources within our society. A large body of literature shows, however, that in the aggregate females and members of minority populations—particularly black, Indian, and Spanish-surnamed populations—have been "underrepresented" in the work place[2] and that those who are employed have been paid less than males and members of nonminority populations—notably members of the white population. Earlier studies

[1] The variations in percentages reflect differences in samples, timing, and research methods among the studies reviewed.

[2] Underrepresentation is defined relative to the available labor pool.

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undertaken by the National Science Foundation[3] also indicate underrepresentation and lower salaries for females and minorities in S/E occupations, although the pay differentials appear to be smaller than those aggregated over all occupations.

As a major employer of scientists and engineers, the Federal Government's treatment of women and minorities is significant. It is significant because the Federal Civil Service is the largest single S/E employer and because the Federal Government should be a leader in equitable treatment of women and minorities in all fields of employment.

This study examines patterns of employment and pay for female and minority scientists and engineers in the Federal Government. Earnings differentials serve as the major focus. Using data obtained from the Civil Service Commission's Central Personnel Data File covering characteristics of some 170,000 scientists and engineers employed by the Federal Government in October 1977, this study describes observed differentials in earnings between men and women and among race/ethnic groups by controlling for factors hypothesized to affect earnings.[4]

[3] National Science Foundation. *Women and Minorities in Science and Engineering* (NSF 77-304) (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office.)

[4] A description of the items contained in the data file and those used in the analysis of salary differentials appears in the technical notes.

## Women and Minority Scientists and Engineers

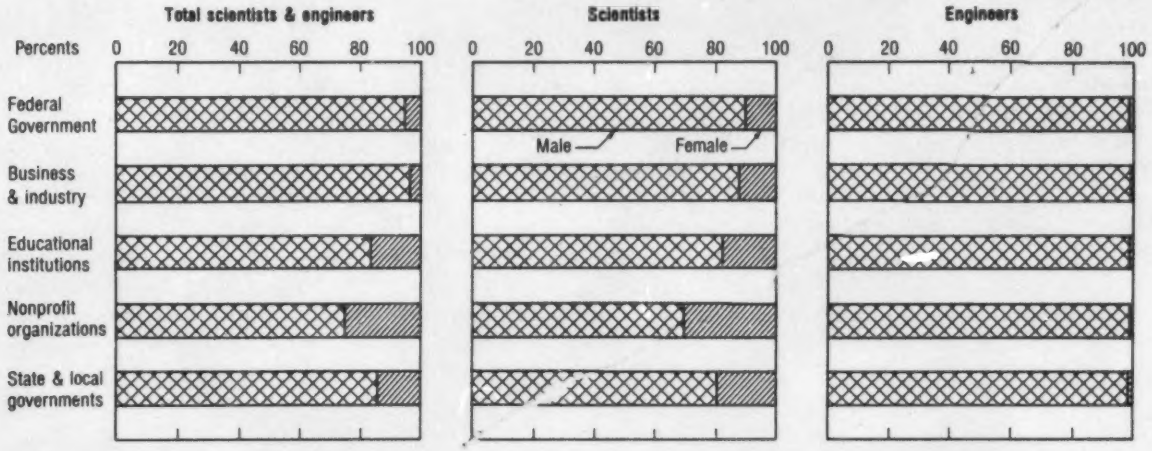
### EMPLOYMENT BY SEX

Among major sectors of the economy, the Federal Government ranks next to last in the proportion of its female S/E work force (chart 1). Almost 9,000 (5.1 percent) of the 170,000 scientists and engineers in the Federal service in October 1977 were women, a percentage which exceeds only the 3.5 percent of female scientists and engineers in the business and industry sector in 1976, the closest year for which comparable data are available.

When these S/E employment figures are further cross-classified by occupational group, other distinctions are observable. Among these is the small proportion of women employed as engineers; only in State and local governments do women make up more than 1 percent of the engineering work force. This low participation of women in engineering in all sectors, along with the heavy representation of engineers in the S/E work force (62 percent of the total), contributes to the low percentage of women in the total S/E population.

An examination of the data for scientists alone shows that women make up 10 percent of the Federal work force, the lowest of any sector tabulated. This small fraction of women scientists in the Federal Government can in part be attributed

**Chart 1. Employment of scientists and engineers by sector of employment and sex: 1976**




SOURCE: National Science Foundation

to the low percentage of women life scientists in this sector.[5]

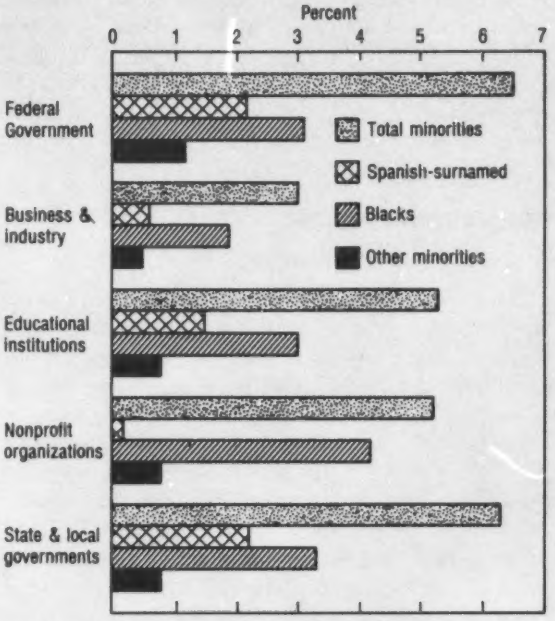
EMPLOYMENT BY RACE/ETHNIC GROUP

Among scientists and engineers employed by the Federal Government, 6.5 percent were classified as belonging to a minority racial or ethnic group in October 1977 (chart 2). Completely comparable data are not available for other sectors of the economy, but similar data for these sectors are also shown in chart 2.[6] Despite the noncomparable data, it appears that the Federal Government employs proportionally more minorities than any sector besides State and local governments.[7] For example, 1 out of 5 black scientists and engineers is employed by the Federal Government, compared to 1 out of 12 white scientists and engineers.

## Secular Patterns of Utilization

When examined by age group, patterns emerge which might indicate that race/ethnic group and sex differences in Civil Service employment of scientists and engineers are decreasing (chart 3). For example, women represent 27 percent and 15 percent, respectively, of the two youngest age groups, far above their overall representation in total S/E employment (5 percent). A critical question in determining whether the future Civil Service work force will have a higher proportion of women is whether these younger women will remain in the Federal service. Available data show that women constituted 12.4 percent of new hires in 1976, but made up only 7.9 percent of

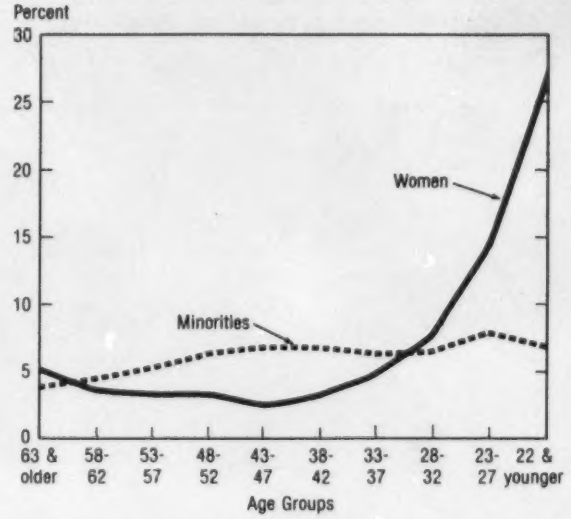
**Chart 2. Science/engineering work force by type of employer and minority group: 1976**




SOURCE: National Science Foundation

scientists and engineers who left Federal Government employment in 1977. Continuation of such a relative gain should produce a gradually increas-

**Chart 3. Women and minority employment in Civil Service science/engineering work force: October 1977**




SOURCE: National Science Foundation based on data of the Civil Service Commission.

[5] This reflects the proportionally greater representation in the Federal life scientist work force of occupations such as range and forest managers, which are typically male-dominated.

[6] The data for other sectors are from National Science Foundation, *Characteristics of Experienced Scientists and Engineers, 1976 (Detailed Statistical Tables)* (NSF 78-305) (Washington, D.C., 1978). These data do not include scientists and engineers who entered the labor force after 1970 and do not include Spanish-surnamed S/E workers whose racial designation is "White/Caucasian." The former exclusion probably leads to an understatement of employment of minorities and women in these sectors relative to the Federal Government, since the representation of these groups in S/E graduating classes has generally been increasing since 1970. The latter exclusion clearly leads to an understatement of the proportion of minorities reported for other sectors relative to the Federal Government.

After subtracting all Spanish-surnamed scientists and engineers from the Federal Government estimate the representation of minorities is at least equal to that of the other sectors.

ing proportion of women scientists and engineers in the Federal Government.

The data on Civil Service employment by ethnic group and age also show an increase in minority employment in the younger groups, although it is not as clear or as striking as the increase in the proportion of women. Minorities represented over 20 percent of new hires in 1976, but only about 7 percent of separations.

## Salary Differentials

### BY SEX

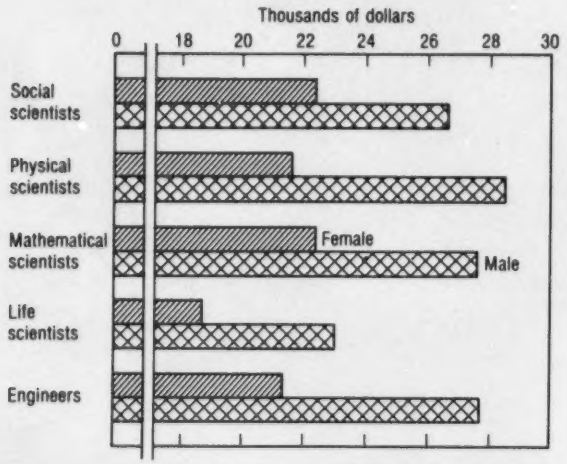
Overall, male scientists and engineers employed in the Civil Service earned about 25 percent more in 1977 than comparable females ($27,000 vs. $21,600). When grouped by occupation, salary differentials ranged from 18 percent for life scientists to 33 percent for physical scientists (chart 4). These two S/E occupational categories were also the lowest and highest, respectively, in terms of overall mean salary.

When classified by level of education, the earnings differential is more clearly in favor of men with bachelor's degrees and no degrees, 30 percent and 32 percent, respectively, and generally narrows with increasing attainment (chart 5).

### BY RACE/ETHNIC GROUP

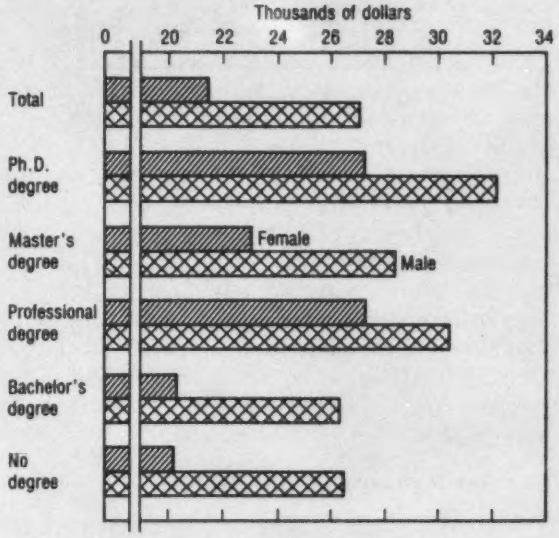
Nonminority scientists and engineers earned about 11 percent more than blacks, 13 percent more than those with Spanish surnames, and 7 percent more than members of other minority groups (Asians, American Indians, and others). These differentials are about one-half, or less, those reported between men and women. As in the case with women, the salary gap favoring whites over minorities generally increases at lower levels of education (chart 6).[a]

**Chart 4. Mean salary of Civil Service scientists and engineers by occupation and sex: October 1977**




SOURCE: National Science Foundation based on data of the Civil Service Commission.

**Chart 5. Mean salary of Civil Service scientists and engineers by educational level and sex: October 1977**




SOURCE: National Science Foundation based on data of the Civil Service Commission

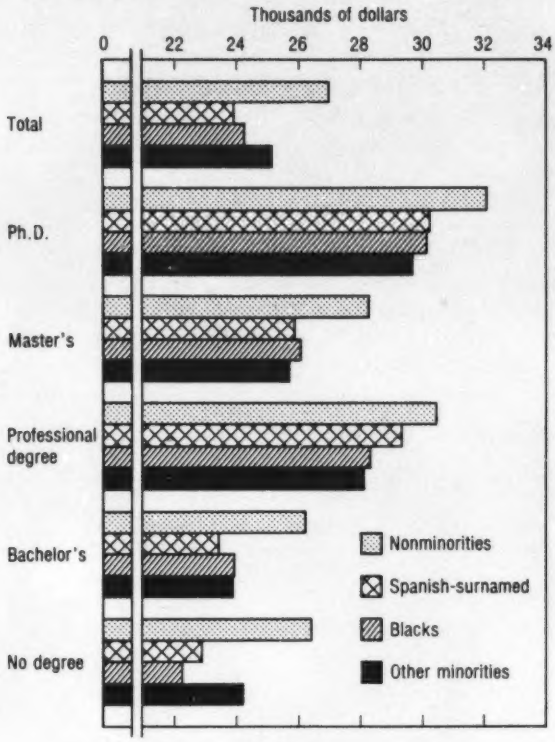
## Method

This section assesses the extent particular factors—e.g., age, education, location, type of work activity, and other characteristics—contribute to observed sex and race differences in earnings of federally employed scientists and engineers. The factors examined include: age, length of government experience, level of education, minority status (in the analysis of sex differences), region of employment, primary work activity, and Civil Service tenure status.

The analysis disaggregates observed differences into two components: (1) the "characteristics" differences—the proportion of the observed difference that can be attributed to the particular

[a] The exception is the "Other minorities" group, whose salary differential is greatest at the master's-degree level and falls slightly for bachelor's degree-holders and for those with no degree.

**Chart 6. Mean salary of Civil Service scientists and engineers by education level and minority status: 1977**




SOURCE: National Science Foundation

factors examined in this study; and (2) the "net" or "unexplained" difference—the difference between the observed difference and the characteristic difference. The latter difference—the "net" or "unexplained" difference—reflects the effects of factors other than those examined in this study. Thus, the "net" difference can reflect the effect of such excluded factors as job conditions or discriminatory practices. The mathematical derivation for the disaggregation can be found in the technical notes (p. 9).

The method used to accomplish this disaggregation can be summarized in the following steps:

(1) the effects of the particular factors examined on earnings by group status are estimated using multiple regression analysis;

(2) The coefficients derived from (1) are used to estimate what females would have earned if they had the characteristics of males, or what minorities would have earned if they had the characteristics of nonminorities.

(3) The earnings estimated in (2) are subtracted from the actual earnings of females (or minorities) to derive the "characteristic" difference;

(4) The "net" or "unexplained" difference is derived by subtracting the "characteristic" difference estimated in (3) from the observed sex or minority group difference. The results represent differences (between sexes or between whites and minority groups) in the way the market evaluates the characteristics controlled for in step (2).

## Empirical Findings

### REGRESSION ANALYSIS

The effects of sociodemographic characteristics on earnings were estimated using multivariate regression analysis. The technical notes (p. 9) describe in detail the variables included in the analysis. Tables A and B provide examples of the empirical analysis with sex differentials in earnings as illustrations of the methods used.[9]

The results of this regression analysis indicate that all of the factors considered in the study have statistically significant effects on the earnings of federally employed S/E workers. These factors account for roughly two-thirds of the observed variation in the earnings of Civil Service S/E workers.

The returns from education[10] are greater for females than males. Federally employed women scientists and engineers with a Ph.D. earn 22 percent more, on an average, than comparable women with a master's degree. The differential for men is 17 percent. A master's degree ensures 13 percent greater earnings than a bachelor's degree for females, and 9 percent for males. The bachelor's degree-holder earns 8 percent more, on an average, than a no-degree-holder for women, but just 4 percent for male scientists and engineers in the Federal Civil Service.

Federally employed scientists and engineers working in the Washington, D.C.-Md.-Va. Stand-

[9] The full details of this analysis as well as a more detailed technical development of the methods used in this study can be found in National Science Foundation, "Women and Minority Scientists in the Federal Government," forthcoming.

[10] The returns from education as discussed here refer to the incremental earnings for each sex. Although returns (i.e., incremental earnings) to a Ph.D. might be more for females than males, the level of earnings of male Ph.D.'s is greater than female Ph.D.'s.

ard Metropolitan Statistical Area (SMSA) earned, on an average, more than comparable scientists and engineers working outside of this SMSA—about 8.5 percent more for females and 13 percent more for males. This effect may be due in part to the higher cost of living in the Washington area. Although Civil Service salary schedules do not formally recognize this as a criterion for increased pay, there may be an informal upgrading of Washington-based employees.

Age and length of Federal Government service both had positive effects on earnings. The squared values of both age and length of Government service were used as independent variables in the regression equations to test the hypothesis, derived from human capital theory, that these variables have a decreasing effect as the age/experience interval increases.[11] The coefficients of both these squared variables had the expected negative sign, supporting this hypothesis. For female scientists and engineers in the Civil Service, one additional year of age was associated with, on an average, a 3.6-percent increase in earnings; 10 additional years generally indicated a 32.6-percent increase. For males, an additional year of age usually meant an average salary increase of 4.6 percent while 10 additional years was associated with an average salary increase of 41.7 percent. A possible reason for this sex differential is the greater likelihood that females will experience interruptions in their work careers, for example when they take time out to raise families. Such interruptions would make the age variable a poorer proxy for work experience for women than it is for men.

The sex differential reverses with the use of values indicated in the regression equations for returns to Federal Government service. Here, a year of such service is associated with 2.2 percent more salary for women scientists and engineers, and 1.8 percent for men. Ten years additional service is associated with 19.0 percent more salary on an average for females, and 15.5 percent more for males. The relatively comparable salary increments associated with increments in Federal work experience (compared to the substantially larger increments for men associated with age) support the hypothesis that females may have a greater likelihood of interrupting their work careers.

[11] To depict this nonlinear effect of experience on earnings, the following functional form is used to describe the earnings function: $y=f(e, e^2, z)$, where e represents experience (in years) and z represents a vector of other variables in the earnings function. The hypotheses derived from human capital theory are $\frac{\partial y}{\partial e} > 0$ and $\frac{\partial^2 y}{\partial e^2} < 0$. The positive sign of the first derivative and the negative sign of the second derivative produce an earnings profile in which the effect of experience on earnings is positive at low values of e, decreases as e increases, and, beyond some critical value of e, becomes negative.

## DISAGGREGATION ANALYSIS

After the effects of the sociodemographic factors discussed above were estimated, observed earnings differences between males and females and between whites and other racial/ethnic groups were disaggregated into characteristic differences (based on the results of the regression analyses) and net (or unexplained differences) (table 1).

### Differences between males and females

For federally employed scientists and engineers, in all occupations females have average

**Table 1. Estimates of wage differentials of scientists and engineers employed by the Federal Government by sex and racial/ethnic group: October 1977**

| Group | Observed differential[a] (1) | Unexplained differential[b] (2) | Unexplained differential + observed differential (3) = (2) + (1) |
|---|---|---|---|
| **Male/Female:** | | | |
| All S/E occupations | 0.25 | 0.07 | 0.30 |
| Social scientists | .20 | .03 | .17 |
| Physical scientists | .33 | .17 | .51 |
| Mathematical scientists | .24 | .10 | .40 |
| Life scientists | .18 | .05 | .26 |
| Engineers | .31 | .09 | .30 |
| **Age Groups:** | | | |
| 63 and older | .10 | .22 | 2.22 |
| 58-62 | .10 | .11 | 1.10 |
| 53-57 | .19 | .16 | .83 |
| 48-52 | .19 | .16 | .82 |
| 43-47 | .20 | .09 | .46 |
| 38-42 | .16 | .07 | .40 |
| 33-37 | .09 | .04 | .47 |
| 28-32 | .04 | .02 | .41 |
| 23-27 | .07 | .02 | .23 |
| 22 and younger | .16 | .06 | .37 |
| **Race/Ethnic Group:** | | | |
| Spanish-surnamed | .13 | .06 | .46 |
| Black | .12 | .08 | .67 |
| Other minority | .08 | .05 | .62 |

[a] The observed differential is calculated as the male/female or white/minority wage ratio minus one.

[b] The unexplained differential is calculated as the estimated female (minority) wage before adjustment for characteristics differences/actual female (minority) wage ratio minus one.

Source: National Science Foundation based on data of the Civil Service Commission.

earnings that are 25 percent less than males. This observed differential is lowest among life scientists (18 percent) and highest for physical scientists (33 percent). After accounting for the "characteristics" difference, the "net" or unexplained differential falls to 7 percent for S/E employees in all occupations and ranges from 3 percent for social scientists to 17 percent for physical scientists. Thus, the characteristics difference constitutes a large proportion of the relatively small observed sex differential of 20 percent among social scientists, and is a much smaller share of the observed sex difference of 33 percent among physical scientists.

When the sex differentials are examined by age group, both the observed differences and the proportion of that difference accounted for by the characteristics effect tends to be smaller for the younger scientist and engineer. The smaller "net" or unexplained differential at the younger age groups suggests the effects of factors that have not been accounted for in this study—factors such as differences in job preference, differences in natural abilities, or discriminatory practices—or that male/female salary differentials for younger Federal S/E employees are relatively less serious than they are for older age groups.

**Table 2. Estimates of wage differentials by sex and race**

| Source | Sample | Observed differential[a] (1) | Unexplained differential[b] (2) | Unexplained differential ÷ observed differential (3) = (2) ÷ (1) |
|---|---|---|---|---|
| | **Male/Female** | | | |
| Blinder | White workers over age 25, 1967 | 0.57 | [c] 0.58 | 1.02 |
| Cohen | Nonprofessional workers aged 22-64 who worked 35 + hours per week, 1969 | .74 | [d] .54 | .73 |
| Fuchs | Nonfarm employed workers, 1959 | .67 | [e] .57 | .85 |
| Malkiel and Malkiel | Professional workers in a single firm, 1971 | .53 | [f] .24 | .45 |
| Oaxaca | White urban workers, 1967 | .54 | [g] .40 | .74 |
| Oaxaca | White, year-round, full-time urban workers, | | | |
| | 1960 | .79 | [h] .56 | .71 |
| | 1970 | .85 | [h] .63 | .74 |
| | **White/Black** | | | |
| Blinder | Male workers over age 25, 1967 | .66 | [c] .43 | .65 |
| Oaxaca (unpublished results) | Male urban workers, 1967 | .36 | [g] .22 | .61 |
| | Male year-round, full-time urban workers, | | | |
| | 1960 | .66 | [h] .37 | .56 |
| | 1970 | .53 | [h] .29 | .56 |

[a] The observed differential is calculated as the male/female or white/black wage ratio minus one.

[b] The unexplained differential is calculated as the estimated female (black) wage before adjustment for characteristics differences/actual female (black) wage ratio minus one.

[c] Control variables: age, geographic region, parental income, father's education, place of birth, place grew up, number of siblings, labor market conditions, geographic mobility, seasonal employment.

[d] Annual hours of work, fringe benefits, absenteeism, seniority, education, unionization.

[e] Race, schooling, age, city size, marital status, class of work, length of trip to work.

[f] Schooling, experience, degree held, publications, marital status, field of study, absenteeism.

[g] Schooling, potential experience, health, part-time employment, migration, marital status, number of children for females, size of urban area, geographic region.

[h] Same as in footnote g minus health.

Sources:


Alan S. Blinder. "Wage Discrimination: Reduced Form and Structural Estimates." *Journal of Human Resources* 8 (Fall 1973): 436-55.

Malcolm S. Cohen. "Sex Differences in Compensation." *Journal of Human Resources* 6 (Fall 1971): 434-47.

Victor R. Fuchs. "Differences in Hourly Earnings Between Men and Women." *Monthly Labor Review* 94 (May 1971): 9-15.

Burton G. Malkiel and Judith A. Malkiel. "Male-Female Pay Differentials in Professional Employment." *American Economic Review* 63 (Sept. 1973): 693-705.

Ronald L. Oaxaca. "Male-Female Wage Differentials in Urban Labor Markets." *International Economic Review* 14 (Oct. 1973): 693-709.

_____. "Sex Discrimination in Wages." In *Discrimination in Labor* Markets, eds. Orley Ashenfelter and Albert Rees. (Princeton, N.J.: Princeton University Press, 1973.)

_____. "The Persistence of Male-Female Earnings Differentials." In *The Distribution of Economic Well-Being*, ed. F.T. Juster. (New York: Columbia University Press, National Bureau of Economic Research, 1977.)

***Comparison with other studies.*** The sex differences in earnings summarized in table 1, both gross and net, are considerably smaller than comparable differences found in studies of all sectors of the economy.[12] These more general studies (summarized in table 2) show observed earnings differentials by sex ranging from 53 percent to 85 percent in favor of men. The "unexplained" differentials range from 24 percent to 58 percent, still much higher than those found for this study of Federal S/E employees. The lower bound of each of the ranges was found in a study of professional workers in a single firm. This might indicate that salary differentials result in large measure from interfirm differences in reward structure, or to earnings differentials between professional and nonprofessional workers. By focusing on a relatively homogeneous professional population (scientists and engineers) with a single employer (the Federal Government) the results of the study summarized in this report should be expected to show smaller "net" or unexplained differentials.

**Differences by race/ethnic groups**

Among racial groups, black scientists and engineers employed by the Federal Government earn, on an average, 12 percent less than whites. This represents a gross differential slightly less than that for Spanish-surnamed S/E employees (13 percent), but one greater than for other minorities (8 percent). Subtracting the characteristics differences reduces the unexplained differential to the 5-percent to 8-percent range (table 1).

***Comparisons with other studies.*** Once again, the differentials for federally employed scientists and engineers are considerably smaller than those reported in studies of black/white earnings differentials for workers in all sectors of the economy. Gross differentials in these studies ranged from 36 percent to 66 percent, while unexplained differentials varied between 22 percent and 43 percent (table 2).

[12] Ronald L. Oaxaca, "Theory and Measurement in the Economics of Discrimination," in *Equal Rights and Industrial Relations*, edited by Leonard J. Hausman, et. al. (Champaign, Ill.: Industrial Relations Research Association, 1977.)

## CONCLUSIONS

The Federal Government, with females constituting 5.1 percent of its scientists and engineers, employs proportionally fewer women scientists and engineers than any sector of the U.S. economy but one. The high proportion of women among the younger Civil Service scientists and engineers, combined with the excess of female new hires over departures, implies that women will make up an increasing proportion of the Federal S/E work force.

In the case of minorities, the Federal Government has the second-best employment record among the economic sectors, with 6.5 percent of its S/E employment classified as belonging to minority groups. In this instance, also, the excess of new hires over departures implies that minorities will become an increasing proportion of the Federal S/E work force.

Compensation of women and minorities within the Federal Government with respect to scientists and engineers is more uniform than in other sectors of the economy, although there still exist pay disparities in the Federal sector which are not explained by the analytical methods employed in this study. These pay disparities may be relativeiy small because (a) salary differentials are lower among scientists and engineers regardless of sector of employment; (b) differentials between men and women and among race/ethnic groups in all occupations are narrower within the Civil Service than outside it; or (c) differentials are narrower for federally employed scientists and engineers than for S/E employees in other sectors.

## Demographic and Educational Variables

For this study, the set of characteristics controlled for includes: Occupation, minority group, education level, Civil Service tenure status, geographic area of employment, primary work activity, age of employee, squared age of the employee, and length of Federal Government service.

While the use of most of these variables in a human capital model is common and well supported in the literature, some are peculiar to this data file. For example, it is hypothesized that an employee with permanent career civil service tenure status, an indicator of a potentially successful career, will earn more than an employee with career conditional, temporary or no tenure status. The coding of geographic area of employment as a dichotomous variable (employed in or outside the Washington, D.C.—Md.—Va. SMSA) is designed to test the hypothesis that employment in the D.C. area, where most agency headquarters are located, positively affects earnings.

The variable measuring length of government experience,[11] although a satisfactory measure of Federal Government work experience, is a less-than-adequate measure of total work experience since it does not account for temporary withdrawals from the labor force for nongovernment work experience or other reasons (e.g., a return to full-time schooling or childbearing).

## Derivation of Disaggregation Equations

The effects on earnings of the characteristics enumerated above were estimated using data for the 170,000 scientists and engineers in the Federal work force in 1977. The earnings function that was estimated had the form:

$$Yi = a_0 + \sum_{j=1}^{n} a_j X_{ij} + u_i$$

Where Y represents the earnings of the $i^{th}$ Federal S/E employee (expressed in natural logarithms), $X_{ij}$ represents the value of the $j^{th}$ factor examined for the $i^{th}$ Federal S/E employee, $u_i$ represents a stochastic error term for the $i^{th}$ Federal S/E employee and $a_o$ and $a_j$ are parameters of the earnings function. The earnings function was specified on the basis of human capital theory. These parameters are assumed to be stable for all Federal S/E employees.

Average earnings of female Federal S/E workers may then be expressed as:

$$\text{(a) } \bar{Y}_F = a_{0F} + a_{1F} + a_{2F}\,\bar{X}_{2F} + \ldots + a_{nF}\,\bar{X}_{nF}$$

Where: $\bar{X}_{1F}, \bar{X}_{2F}, \ldots, \bar{X}_{nF}$ represent the average values of these characteristics for female Federal S/E employees, and $a_{1F}, a_{2F}, \ldots a_{nF}$ represent the incremental effects of these characteristics on the earnings of female Federal S/E employees.

Similarly, let average earnings of male Federal S/E workers be expressed:

$$\text{(b) } \bar{Y}_M = a_{0M} + a_{1M}\,\bar{X}_{1M} + a_{2M}\,\bar{X}_{2M} + \ldots a_{nM}\,\bar{X}_{nM}$$

The estimate of what females would have earned if they had the characteristics of males ($\bar{Y}_{FM}$) can be derived by substituting the values of $\bar{X}_{jm}$ for the values of $\bar{X}_{jf}$ in equation (a):

$$Y_{FM} = a_{0F} + a_{1F}\,X_{1M} + a_{2F}\,X_{2M} + \ldots + a_{nF}\,X_{nM}$$

The "characteristics" difference (c) is then expressed as:

$$C = \bar{Y}_F - \bar{Y}_{FM} = a_{1F}\,(\bar{X}_{1F} - \bar{X}_{1M}) + a_{2F} - \bar{X}_{2M}) + \ldots + a_{nF}\,(\bar{X}_{nF} - \bar{X}_{nM})$$

and the "net" or "unexplained" difference (n) is expressed as:

$$N = (\bar{Y}_F - \bar{Y}_M) - C = (a_{0F} - a_{0M}) + (a_{1F} - a_{1M})\,\bar{X}_{1M} + (a_{2F} - a_{2M})\,\bar{X}_{2M} + \ldots + (a_{nF} - a_{nM})\,\bar{X}_{nM}$$

[11] This variable measures total length of government service, but excludes time between separate periods of Civil Service employment.

## Table A. Coefficients and F-value for regressions of salary (log form) of federally employed scientists and engineers

| Independent variable | Total | | Females | | Males | |
|---|---|---|---|---|---|---|
| | Coefficient | F-value | Coefficient | F-value | Coefficient | F-value |
| **Sex** | -0.0775080 | 1378.858 | NA | NA | NA | NA |
| **Occupation:** | | | | | | |
| Employed as a social scientist | -0.1303414 | 5841.295 | -0.0853548 | 87.390 | -0.1359870 | 5645.874 |
| Employed as a physical scientist | -0.1089235 | 5997.884 | -0.1528034 | 260.812 | -0.1050299 | 5412.197 |
| Employed as a mathematical scientist | -0.0546971 | 790.274 | -0.0588908 | 39.407 | -0.0523214 | 649.820 |
| Employed as a life scientist | -0.2537896 | 33481.775 | -0.2192807 | 511.583 | -0.2605804 | 32974.397 |
| **Minority group status:** | | | | | | |
| Spanish-surnamed | -0.0469997 | 138.439 | -0.0306655 | 2.596 | -0.0472706 | 135.019 |
| Black | -0.0606726 | 996.393 | -0.0600097 | 70.249 | -0.0631385 | 900.271 |
| Other minority (Asian, American Indian, etc.) | -0.0474871 | 247.668 | -0.0345324 | 7.779 | -0.0476944 | 236.045 |
| **Education level:** | | | | | | |
| Ph.D. | 0.3099535 | 21400.334 | 0.4250079 | 2095.685 | 0.3012326 | 19196.316 |
| Master's | 0.1344346 | 6455.020 | 0.2114712 | 814.990 | 0.1291690 | 5681.385 |
| First professional degree | 0.1694584 | 1349.865 | 0.3456135 | 331.589 | 0.1571151 | 1096.740 |
| Bachelor's degree | 0.0446813 | 932.385 | 0.0639646 | 161.171 | 0.0419312 | 784.718 |
| **Civil Service tenure status:** | | | | | | |
| Permanent career tenure status | 0.1485673 | 2113.142 | 0.1536662 | 215.638 | 0.1473071 | 1901.075 |
| Career-conditional tenure status | 0.0056354 | 3.006 | 0.0229709 | 5.285 | 0.0040402 | 1.365 |
| Temporary tenure status | 0.1588068 | 672.066 | 0.0756321 | 14.804 | 0.1700175 | 691.267 |
| **Area of employment:** | | | | | | |
| Geographic are of employment (zero if employed in D.C. area, one if employed outside D.C. area) | -0.1312924 | 14153.489 | -0.0847190 | 359.236 | -0.1347578 | 14007.782 |
| **Primary work activity:** | | | | | | |
| Research | -0.0080452 | 28.873 | -0.0274182 | 22.370 | -0.0045645 | 8.600 |
| Research contract and grant administration | 0.1337113 | 553.574 | 0.1601321 | 58.967 | 0.1296770 | 482.213 |
| Development | 0.0029201 | 4.363 | 0.0489844 | 37.325 | 0.0008798 | 0.387 |
| Test and evaluation | -0.0319054 | 225.911 | 0.0045088 | 0.213 | -0.0348083 | 257.131 |
| Design, production, construction, installation, etc. | -0.0712452 | 2747.280 | -0.0539319 | 21.400 | -0.0719893 | 2788.885 |
| **Age and experience:** | | | | | | |
| Age of employee | 0.0450516 | 15191.488 | 0.0362428 | 582.653 | 0.0460128 | 14862.192 |
| Squared age of employee | -0.0004263 | 11358.193 | -0.0003637 | 449.541 | -0.0004352 | 11162.730 |
| Length of government service (years) | 0.0179777 | 12029.984 | 0.0219399 | 848.867 | 0.0176655 | 11000.998 |
| Squared lengh of government service | -0.0002249 | 6394.542 | -0.0002918 | 678.559 | -0.0002191 | 55595.008 |
| (Constant) | 9.0677088 | | 8.9715140 | | 8.9788219 | |

Source: National Science Foundation based on data of the Civil Service Commission.

## Table B. Decomposition of gross salary differentials for federally employed scientists and engineers

| Variable | $A_{iF}$ | $\bar{X}_{iM}$ | $\bar{X}_{iF}$ | $(\bar{X}_{iM}-\bar{X}_{iF})$ | $A_{iF}(\bar{X}_{iM}-\bar{X}_{iF})$ |
|---|---|---|---|---|---|
| **Occupation:** | | | | | |
| Employed as a social scientist | -.0854 | .0820 | .2868 | -.2048 | .0175 |
| Employed as a physical scientist | -.1526 | .1598 | .2313 | -.0715 | .0109 |
| Employed as a mathematical scientist | -.0587 | .0556 | .2009 | -.1453 | .0085 |
| Employed as a life scientist | -.2193 | .1684 | .1959 | -.0295 | .0065 |
| **Minority group status:** | | | | | |
| Spanish-surnamed | -.0307 | .0122 | .0126 | -.0004 | .0000 |
| Black | -.0600 | .0268 | .1043 | -.0775 | .0047 |
| Other minority (Asian, American Indian, etc.) | -.0345 | .0212 | .0312 | -.0100 | .0003 |
| **Education level:** | | | | | |
| Ph.D. | .4250 | .0963 | .1086 | -.0123 | -.0052 |
| Master's | .2115 | .1994 | .2337 | -.0343 | -.0073 |
| First professional degree | .3456 | .0097 | .0142 | -.0045 | -.0016 |
| Bachelor's degree | .0840 | .5835 | .5069 | .0766 | .0064 |
| **Civil Service tenure status:** | | | | | |
| Permanent career tenure status | .1537 | .8429 | .6718 | .1711 | .0263 |
| Career-conditional tenure status | .0230 | .1314 | .2559 | -.1245 | -.0029 |
| Temporary tenure status | .0756 | .0063 | .0147 | -.0084 | -.0006 |
| **Area of employment:** | | | | | |
| Geographic are of employment (zero if employed in D.C. area, one if employed outside D.C. area) | -.0847 | 1.7835 | 1.5611 | .2224 | -.0100 |
| **Primary work activity:** | | | | | |
| Research | -.0274 | .1295 | .2529 | -.1234 | .0034 |
| Research contract and grant administration | .1601 | .0059 | .0109 | -.0050 | -.0008 |
| Development | .0490 | .1525 | .0904 | .0621 | .0030 |
| Test and evaluation | .0045 | .0489 | .0557 | -.0068 | -.0000 |
| Design, production, construction, installation, etc. | -.0530 | .1979 | .0419 | .1560 | -.0084 |
| **Age and experience:** | | | | | |
| Age of employee | .0362 | 42.0347 | 37.0386 | 4.9961 | .1811 |
| Squared age of employee | -.0004 | 1873.4787 | 1500.2321 | 373.2466 | -.1357 |
| Length of government service (years) | .0219 | 14.9157 | 9.8550 | 5.0607 | .1110 |
| Squared lengh of government service | -.0003 | 316.2795 | 208.9018 | 107.3779 | -.0313 |

Source: National Science Foundation based on data of the Civil Service Commission.



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